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PROFESSOR BOAS' NEW THEORY OF THE FORM OF
THE HEAD—A CRITICAL CONTRIBUTION
TO SCHOOL ANTHROPOLOGY

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I. INTRODUCTORY

LAST year a government document was published by the Immigration Commission in which an attempt was made to show that New York environment is bringing about "fundamental" changes in the physical type of immigrants. The author of this document is Professor Franz Boas¹ (i) of Columbia University.

Under his direction the heads of a large number of New York immigrants have recently been measured. These measurements include a study of: (1) the stature; (2) weight; (3) general physiological development of the individual; (4) two head measurements (length and width) and the corresponding cephalic index, indicating "the form of head"; (5) width of face; (6) color of hair, eyes, and skin. A majority of the individuals measured were school children.

The results of this investigation aroused much popular interest and considerable discussion in the daily press, and many popular magazines and semi-scientific journals repeated uncritically the several "unexpected" conclusions. It was widely believed that the results had dealt a death blow to the old theories regarding the stability of the form of the head, because they seemed to show that the form of the head is not a permanent characteristic of race as anthropologists had assumed; that the American environment rapidly affects the form of the head; that Jews are growing long-headed, and Sicilians short-headed, *i. e.*, that the cephalic index of the Jews is decreasing and that of the Sicilians increasing.

More especially on page 39 Boas concluded that

"on the whole, there has been a decrease in length of head, width of head, and width of face since the middle of the past century. . . . A feature that is particu-

¹ Numbers in parenthesis after authors' names or quotations refer to the numbers in the Bibliography at the end of this paper.

larly noticeable is the general drop of all the absolute measurements after the year 1894. An attempt to combine all the material; adult and children, for these years, brings out the sudden drop after 1893 even more clearly; and a similar phenomenon is repeated between the years 1907 and 1909. For this reason I am inclined to believe that the type of immigrants is directly affected by financial panics."

In another place (p. 28) Boas expresses the same conclusions in the following words:

"The type of immigrants changes from year to year, owing to a selection which is dependent upon the economic conditions of our country. This is shown by the fact that after the panic of 1893 a sudden decrease in the general development of immigrants may be observed, which persisted for several years. A similar change seems to have taken place after the panic of 1907."

How the "type" of immigrants was affected after the panic of 1893 is shown in Table III (p. 28) referring to the general deterioration in stature, length and width of head, width of face, and cephalic index (see Table VI of this study). According to these figures the panic of 1893 *decreased* stature, length and width of head, and width of face, but *increased* the cephalic index.

Does this increase and do these decreases affect the physical type of immigrants at all? Are the observed differences significant, and if so, are they due to the American environment and financial panics? Is there any scientific explanation of "far-reaching" changes in this new theory? Does it really mean a discovery in anthropological science that is of "fundamental" importance?

Before we enter into this large subject it is necessary to remind the reader of the older notions concerning the form of head, because it will help us in localizing various very important difficulties involved in the problem, and throw a new light on Boas' material and his explanation of it. Boas himself admits frankly that his "surprising and unexpected" results require "the most thorough-going criticism before being accepted as definitely established." We also believe that a healthy criticism will be beneficial.

II. HISTORICAL: ON THE FORM OF THE HEAD

Until the appearance of this new theory, the historical answers to the question, "Does the form of the head change?" may be summarized in the following theories:

1. *The Mechanical-functional Theory*

According to this theory the shape of the head may be caused by the mechanical influences during the postnatal life. Thus the head-form may be modified individually by the kind of cradle in which baby sleeps. In his *Descent of Man*, Darwin says that the

"habitual spasm of the muscles, and a cicatrix from a severe burn, have permanently modified the facial bones. In young persons whose heads have become fixed either sidewise or backward, owing to disease, one of two eyes has changed its position, and the shape of skull has been altered apparently by the pressure of the brain in a new direction." (2)

He quotes Jarrold's *Anthropologia* (1880, pp. 115-6) in which are given the cases of modification of the skulls from the head being fixed in an unnatural position. Darwin says that Jarrold believed "that in certain trades, such as that of a shoemaker, where the head is habitually held forward, the forehead becomes more rounded and prominent." (2)

In another place Darwin says that the skulls of many of our improved and domesticated species of animals have varied perceptibly; and he cites in addition pigs, diverse species of fowls, and rabbits. From his own observations on domestic rabbits he inferred that some kinds of skulls

"have become very much larger than in the wild animal, while others have retained nearly the same size, but in both cases the brain has been much reduced relatively to the size of the body. Now I was at first much surprised on finding that in all these rabbits the skull had become elongated or dolichocephalic; for instance, of two skulls of nearly equal breadth, the one from a large domestic kind, the former was 3.15 and the latter 4.3 inches in length." (3)

He also thinks that the tall men may be compared with the larger and longer-bodied rabbits, all of which have elongated skulls, or are dolichocephalic (2). And about fifty years ago, a German anthropologist, Welcker (4), found that short men more frequently have rounded heads and tall men elongated ones.

The mechanical-functional theory has been supported in quite recent times by a Stockholm anthropologist, Nyström (5), who believes that the form of head may change under the influence of diet. The osteologist Holden (6) claims that different habits develop different muscles, and that these muscles give rise to

modifications in the form of the bones as well as the bodily configuration. In short, function makes structure. He contrasts the skulls of the *Carnivora* with those of the *Ungulata* (or hoofed animals). His examples are the tiger and deer. He says:

"The skull of the tiger is in perfect adaptation to his enormous temporal muscle. It has a high median ridge, to which the muscles are attached, great arches of the zygoma, under which they pass, and broad and lofty coronoid processes, into which they are inserted. But his masseters are comparatively small, therefore the zygomata and the angles of the jaw are not specially strong. Now, the sole action of this temporal muscle is to clench the teeth together as on a hinge; so we find that his jaw articulation is hinge like, and allows no other motion. This mechanism is admirably fitted for cutting purposes, but is quite unfit for grinding; so his teeth are cutters. He has no grinders. Exactly the converse of all is true of the deer: his temporals are small; he has no median ridge, the passage under the zygoma is small, and his coronoid process is delicate and scarcely deserves notice. On the other hand, his masseters and pterygoid plates are greatly expanded, the angles of the jaw massive and extensive. The masseters acting with the internal pterygoids cause the grinding action; so here the articulation of the jaw is nearly flat, allowing of a free grinding movement; and in accordance with this, we find the teeth are flattened on the surface, and good grinders. It will be seen how clearly this conformation is in keeping with the habits and nature of each animal"(6).

And the slight differences between opposite sides of the same skull is explained by Holden on the basis of the law of Cuvier (7): "That an invariable co-relation exists not only between the different parts of an animal's body, but likewise between the parts of his body and his mode of life."

Holden says that

"the posterior condyloid foramen of one side may be wanting, the mastoid process of one side may be larger than that of the other, or the digastric fossae may be of unequal size; one nasal passage may be larger than the other; the lateral sinus may be much deeper on the one side than on the other, or there may be a middle clinoid process on one side only. Asymmetry may occur in men highly gifted as in the celebrated French anatomist Bichat. This is no more than one might expect, seeing the difference often existing between features of the two sides of the same face. Such want of symmetry is greatly exaggerated in many of the lower animals, as may be seen in the Cetacea, in the head of the great sperm-whale, or in that of the narwhal. . . . But the most striking example of asymmetry is seen in those of flat-fish which lie usually on their left sides, viz., soles and plaice. . . . For in them both eyes are on the right or upper side of the skull, and one orbit only is completed, the eyes being directed away from the ground on which they lie. The teeth are chiefly developed on the left side of their jaws—

away from the side on which their eyes are—that is, on the white side. It is interesting to note that in those fish, when very young, the skulls are symmetrical. When the turbot is just hatched, it has an eye on each side of the head, and it is only by subsequent development that the asymmetry occurs. The turbot, unlike the sole and plaice, lies on its right side" (6).

Holden says, further, that the

"great and heavy skull of the crocodile contains large nasal passages and air-cavities which float it, so that its body can lie under the water while its eyes and nostrils alone appear just above the surface" (6).

In regard to the fact that some human heads are long, some broad, and others round, Holden claims that it is due to "the varying extent of growth of bone either in the transverse or the longitudinal sutures," or to "the early union of one or other of them." So in the case where the parietal bones unite very early,

"the skull was unable to accommodate the growing by increasing in breadth, and therefore, could only increase in length by growing at the fronto-parietal and the occipito-parietal sutures, thus giving rise to these extraordinary long skulls" (6).

Holden goes so far as to claim that "the history of the animal is always written on its bones," and that "low degraded types have skeletons which can not be mistaken, while the healthy, intelligent, and upright carry their characters in their skeletons as much as they do in their faces."

Müller (8) claims that there is a close relation between the form of head and the mechanism of birth. He gives many illustrative examples from his own observations. Görke (9), Papillault (10), Haeckel (11), and others studied these mechanical influences in the light of functional shaping of skulls, based on the ontogeny and phylogeny of the human skull. In more recent times R. C. Osburn (12) studied the effects of the shape of skulls on the teeth of man. All these factors show the great complexity of the problem. (See especially Hrdlička, Eskimos, effects of temporal muscles on form of jaws and head.)

2. *The Hereditary Theory*

This theory is one of the oldest. But it has at least the following three forms:

a. *The First Form of the Hereditary Theory.*—According to this

theory *the shape of head is not changed*; it is one of the clearest of all permanent hereditary differences; it is relatively uninfluenced by climate, age, food, locality, and exercise. This theory is in one form or another advanced by Myers (13), Spitzka (14), Möbius (15), Rieger (16), G. Stanley Hall (17), Zupanchich (18), and other craniologists, archeologists, and so-called "anthropo-sociologists" (19).

So, for example, Myers found that the chief head measurements show approximately the same variability in the "prehistoric" people of Upper Egypt as in the modern population of the same region. A pupil of Prof. Martin (former director of the Anthropological Laboratory of the University of Zurich), Oettking (20), came to the conclusion that the influence of Bushmen, Negroes, Libyans, and Hamito-Semites upon the Egyptian skulls can not yet be given exact craniometric expression. Keith (21), in his study of the remains of an ancient Briton, the Galley Hill man, was "struck" with the modernity of his form of skull, *i. e.*, the extreme length and extreme narrowness of his head, which is the "national" characteristic of modern Englishmen. Similar results are reached by a Croatian anthropologist, Gorjanovich (22). We might also mention the fact that the form of skull of a Scandinavian of the neolithic time is very similar to that of the modern Scandinavian. There are other cases of this kind.

From both Myers' and Keith's investigations one is led to conclude that age alone does not produce in a people increased heterogeneity. Keith says that the history of man in England does not begin some 5,000 years ago with an invasion of Celt or of Saxon, but at a period of which 5,000 years is but a small fraction. This theory has recently been advanced also by a Slovenian anthropologist, Zupanchich, in his lecture given last year at the University of Belgrade (Serbia) (23).

In short, the theory that the shape of the head is stable, hereditary and not fortuitous is the first form of the hereditary theory.

b. The Second Form of the Hereditary Theory.—This form of the hereditary theory holds that *the shape of the head is inherited, but that it does not assume its final shape until after birth*, and that it

does not depend on the mixed parental value of the cephalic index. O. Ranke (24), in his study of the form of the head of 4,607 German children (the age ranging from a new-born infant to a child of 15), concludes that the form of the head reaches its definite form relatively early, at seven, or even at six years of age. Sir W. Hamilton also says that in man the encephalos reaches its full size at about seven years of age (25). Vosilyev (26), who studied 936 boys and 264 girls between the ages of 7 and 16 years, belonging to the district of Szerpuchov, in the Government of Moscow, found that the form of head does not finally shape itself until after the sixteenth year. Pfitzner (27), who studied 3,660 cases in Elsass, also found that, apart from sex and age, the cephalic index seems to be the only absolutely fixed character for the determination and recognition of individuals.

Boas (28) in another study, in 48 families of eastern Jews, measured by Fishberg, states that one half of the children resembled the father in regard to the shape of head and the other half the mother. But the results of O. Ranke (29), based on head measurements of children of the same parents (51 families) do not substantiate Boas' conclusions. Ranke found a very striking resemblance in the form of head of all children of the same parents, regardless of the fact that the brothers and sisters were of different ages (ranging in age from 3 to 14 years), with two or three exceptions. Ranke's results agree with those of Thorndike (29a) who found that 35 pairs of twins of New York City showed a striking resemblance in cephalic index. Thorndike measured 50 pairs of twins from 9 to 15 years old; 58.5 per cent. of these school children showed brachycephaly, 37.1 per cent. mesocephaly, and 4.3 per cent. dolichocephaly.

Gray and Tocher (30) also found very little difference in the cephalic index of the racial elements of 14,561 pupils in east Aberdeenshire, England. Binet (31) in France, Tscherskovsky (32) and Viasemsky (33) in Russia, and many others, came to almost the same conclusion (34). Matiegka (35), studying some 7,000 boys in the public schools of Prague, from 5½ to 14 years of age, found throughout those ages the same national, brachycephalic

type of the head. The measurements by two pupils of professors Meumann and Martin, Engelsperger and Ziegler (36), of 238 boys and 238 girls of the entering classes (average ages 6 years and 4.5 months) in the schools of Munich, show that the bulk of these pupils had the national form of the head—93.5 per cent. being brachycephalic and only 6.5 per cent. mesocephalic (not a single case of dolichocephaly). Schliz (37), studying 962 school children (from 12 to 14 years of age) in Heilborn, also found that the large majority of these children represent the brachycephalic type of head-form. The same is found by a pupil of Professor Martin, Teumin (38), who measured 100 female university students (mostly of Jewish race) in the Anthropological Laboratory of Zurich University. The bulk of these students were brachycephalic—74 per cent.

Browne (39), who measured the students of Trinity College (from 1891 to 1898), found an average cephalic index of 72.5, which is the national type of the head of Englishmen. The same result was found by Venn (40), who measured 1000 students of Cambridge University (England). The majority of these students were mesocephalic—55.2 per cent.

In addition to these we may mention the study of a Polish author, Kraitschek (41), based on the measurements of 173 Jewish students of the State Gymnasium in Landskron (Galicia, Austria). He found not a single dolichocephalic student; only three were mesocephalic and the rest, 170 in number, were of a brachycephalic type (98 per cent.).

All these and many other studies show clearly that the youth represent the same type of head as the race to which they belong, with slight differences in degree, of course. This is the second form of the hereditary theory.

c. The Third Form of the Hereditary Theory.—This form of the hereditary theory claims that the *shape of head* (or rather skull) *is inherited*, but "heredity" means not absolute stability. Hrdlička (42), believes that heredity is subject to incidental irregularities as well as to gradual modifications. He thinks that the alterations in the skull

"need not be general or of prime importance, and may require for their dis-

covery detailed study and extended comparisons; but in the case of an individual from the earlier stages of the geological period immediately preceding the recent one they should as a rule be pronounced enough to be easily apprehended."

Hrdlička is very careful in using generalizations. He says:

"In the case of single features or with scanty material, all far-reaching conclusions must be avoided, for in such cases we can not be certain that we are outside of the territory of semipathological occurrences, and features of reversion, degeneration, or purely accidental variation limited to individuals or small numbers of persons."

Hrdlička's scientific sanity and exactness in measuring crania might be compared with the craniological work of Klaatsch (43), Kollmann (44), Martin (45), and other European experts in experimental physical anthropology.

3. *The Geographical-local Theory*

This theory is not unlike the preceding. It claims that the shape of the head is distributed more according to geographical localities than to nationalities. So, for example, the people of the Alps, no matter what language they may speak, show considerable similarities in type. Deniker (46), who analyzed and utilized all that has been published in different languages on the cephalometry and craniometry of European peoples (the total number of indices examined represent about 380,000 measured individuals or skulls), concludes that the cephalic indices are distributed over four groups of well defined areas, *viz.*, a dolichocephalic area, with mesocephalic *enclaves*, in the north of Europe; another more pronounced dolichocephalic area in the south of Europe; an area of strongly brachycephalic heads in the center of western Europe, and, finally, a sub-brachycephalic area in eastern Europe. A similar cephalic "world map," constructed from data on living men, and "sufficient in amount to eliminate the effects of chance," is given by W. Z. Ripley (47).

Beddoe (48), in studying 200 boys (16 and 17 years old) found that those belonging to the navy have larger heads than those of the reformatory and industrial schools. If anything, he says, their heads are slightly broader, but within the limits of error. He concludes that the differences in the form of head are connected with

the locality rather than with any other condition or characteristic. But Gray and Tocher, who measured about 15,000 school children from 93 schools, covering 30 parishes, in England, could not draw such a conclusion; they found only a very little difference in the cephalic indices of the racial elements, *i. e.*, something racial to heredity.

According to Ammon's (49) investigation the longheaded individuals are concentrated more in the city than in the country. In studying the recruits of Baden and "Gymnasialschüler" from Karlsruhe and Mannheim he found that the *urban class* (those whose fathers were of city birth, as well as themselves), the *semi-urban class* (those born in cities, but whose fathers were immigrants from the country), and the *semi-rural class* (those born in the country who had migrated to the city), as compared with those who remained in the country, show a regularly increasing dolichocephaly in each generation. He believes that the longheaded individuals are intelligent, or, as he calls them, "die Auserlesenen," the selected, because they have either the energy or the physical ability to seek their fortunes at a distance from their rural place of birth. This theory of cephalic superiority was accepted by many anthropologists (50). But others say that the percentage of dolichocephaly decreases with the progress of civilization. J. Ranke (51), who studied the "Reihengräber" of Bavaria, the skulls of Lindau, and the skulls of modern Bavaria, found a very regular decrease of dolichocephaly and an enormous increase of brachycephaly:

| | Reihengräber of Bavaria | Lindau | Modern Bavaria |
|--------------------|-------------------------|--------|----------------|
| 1. Dolichocephaly: | 42 | 32 | 1 |
| 2. Mesocephaly: | 44 | 36 | 16 |
| 3. Brachycephaly: | 14 | 32 | 83 |

Weisbach (52) also found a brachycephalic index for the contemporary Austrian Germans. According to Livi (53) in northern Italy the professional classes are more dolichocephalic than the peasants, but in the south the reverse is the case. Topinard (54) says that the cephalic index

"varies in the human races from 71.40 in Greenlanders to 85.63 in Lapps, in the averages of the series; and from 62.62 in a New Caledonian to 92.77 in Slav

(Wend) in particular instances. The difference is greater if we include the distorted skulls. A scaphocephalus in the Laboratory of Anthropology has an index of 56.33, and a Peruvian skull of an Inca, one of 103."

Our intention is not to criticize here all these more or less different theories. All who are familiar with the sources of these investigations will agree that in many cases it is very hard to decide what are the reasons of very great differences in the form of the head. These differences appear to be due partly to the differences of race, but also, unfortunately, partly to the differences in the methods, and precision of measurements, and in the mathematical calculation. It is, therefore, almost impossible to tell in many cases whether a difference is due to inaccuracy or to variation of individuals. The past of craniological and cephalometrical studies moved along the horizontal rather than along the vertical line, a big collection of anthropological data being made without deeper explanation of it. President G. Stanley Hall is right in saying that there are so few problems in this field yet solved that the great number of cephalometric and craniometric measurements sometimes insisted on seem at present little more than affectation (*Adolescence*, vol. 1, p. 72).

Evidently further careful studies and investigations are necessary before any dogmatic statement can be made. Does Boas' new theory present a hope of reaching such a goal? Did he utilize elementary errors of previous investigators? Did he grasp the difficulties of their theories in shaping his own theory? Is his investigation a progress or regress in experimental physical anthropology in general and in school anthropometry in particular?

III. THE NEW THEORY IN RELATION TO RESULTS

We thought it would be in place to point out the main theories of the origin of the form of the head before we take up the theories of Boas, based on his study of immigrants and their descendants. His new views do not agree with any previous. He himself is opposed to the first, the mechanical theory. On page 51 of his report he says:

"It seems conceivable that the change in the length of the head might be due to the treatment of the infant. While the children born abroad are swathed, the

method of treatment in families living in America is entirely different. The swathed child lies on its back, and the continued pressure upon the occiput might bring about a slight shortening of the skull. All the data relating to correlation between width of head and length of head are opposed to this assumption."

He is not an enthusiast for the hereditary theory either, because, he says, the head changes may be inherited, and yet not necessarily reproduce the characters of the parents. He believes that it is quite possible that we can leave the problem of the head entirely out of consideration.

He also does not agree fully with the third main theory, the geographical-local theory. On page 32 of his report he says that no evidence has been collected which would show an actual change in type due to the direct influence of environment, because the type of immigrants changes from year to year, owing to a selection which is dependent upon the economic conditions of our country, "far-reaching" changes in "type" which "can not be ascribed to selection or mixture." According to Boas the racial characteristics do not survive under the new social and climatic environment of America. We may, therefore, call Boas' theory the *environmental-economic theory*, the first theory of its kind; *environmental*, because it claims that the descendants of the European immigrants change their type "*even in the first generation almost entirely.*"

"Children born not more than a few years after the arrival of the immigrant parents in America develop in such a way that they differ *in type (!) essentially* from their foreign-born parents. These differences seem to develop during the earliest childhood and persist throughout life. It seems that every part of the body is influenced in this way, *and even the form of the head, which has always been considered as one of the most permanent hereditary features, undergoes considerable change.*"¹

The theory may be called *economic*, because it claims that the panics of 1893 and 1907 caused a "sudden decrease in the *general* physical development of immigrants" and a "sudden" increase in the cephalic index.

But before accepting these unexpected scientific results unqualifiedly they should first be sifted by those who at least know the immense difficulties in attacking such complicated problems.

¹ Here, as throughout this study, the Italics are mine.

Therefore, this critical study. Our purpose is to follow step by step the scientific validity of Boas' results on the shape of the head and his interpretations of them. We will follow the order of his summary:

a. Boas' First Conclusion

"The head form which has always been considered as one of the most stable and permanent characteristics of human races, undergoes *far-reaching changes* due to the transfer of the races of Europe to American soil. *The East European Hebrew, who has a very round head, becomes more long-headed; the south Italian who in Italy has an exceedingly long head, becomes more short-headed; so that both approach a uniform type in this country.*"

But what is the nature of these "far-reaching changes," and do they really affect "the type" of the form of the head? For the sake of concrete illustration let us compare Boas' results with those of Hoesch-Ernst (56), Hrdlička (55), Landsberger (57), Muffang (62), O. Ranke (58), Reuter (59), West (60), Windle (61), and the results of the study of the Edinburgh and Aberdeen school children (63). Table I gives this comparison.

Before attempting to make any comparison and draw any conclusion, let us clearly state that anthropological science discriminates few types of the head as indicated by the *cephalic index* (generally called the "cranial index," or "latitudinal index" or "index of breadth," *in contrast* to two other altitudinal cephalic indices, *viz.*, the "vertical index" or "index of height" or the length-height cephalic index, and the breadth-height cephalic index). It is a ratio between the width (or breadth) of head and the length of the head. Say the width (W) is 142 mm. and the length (L) 180 mm. Then the cephalic index (x) is found as follows:

$$180 : 100 = 142 : x \quad \text{or} \quad x = \frac{142 \times 100}{182} = 78.$$

$$\text{In short the formula of this index is: } x = \frac{W \times 100}{L}.$$

This method of determination of cephalic (or cranial) index was introduced by a Swedish anthropologist, Andreas Retzius (1742-1821) (64). By measuring the skulls he found two extreme indices: the *long* or dolichocephalic and the round, *broad*, or brachycephalic.

TABLE I

[illegible]

Later this number of types was increased to five. Today anthropological science discriminates three main types of the form of head as indicated by their indices:

- (1) Long-headedness (or dolichocephaly) $x - 74.99$.
- (2) Medium-headedness (or mesocephaly) $75 - 79.9$.
- (3) Broad-headedness (or brachycephaly) $80 - x$.

This is the classification of Török (65), Reuter, Fishberg (66), and others. Let us now see what the above mentioned "far-reaching changes" mean.

If we compare Boas' average figures for American-born and foreign-born Hebrew boys and girls we see that at all ages both are of the *same type*—they all are broad-headed. And if we agree with those authors (Martin (67), Engelsperger and Ziegler, etc.), who classify broad-headedness into sub-brachycephaly ($80-86.9$) and hyper-brachycephaly ($87-x$) we shall find that both belong to the same division, sub-brachycephaly. Not one single year is represented by hyper-brachycephaly (except the Hebrew foreign-born girls whose average index is just 87, which is, according to O. Ranke's classification, also under sub-brachycephaly).

Or let us take the Sicilian boys. Boas concludes that the south Italian, who in Italy has an "*exceedingly long head*," becomes more "*short-headed*." But his average values show that not *one single* year measured is represented by exceeding long-headedness. The index of such long-headedness (technically called "hyper-dolichocephaly") is below 70 (according to Hoesch-Ernst's classification), and the figures for Sicilians show a minimum of 76, which represents a mesocephalic type of the form of head.

In short: *It appears that Prof. Boas' own figures or results do not prove his conclusions.* It may perhaps be contended that these figures are only averages. To this we may reply: *first*, that it is not customary to draw "entirely unexpected" conclusions from mere averages,—a method which has been condemned both in America and in Europe; *second*, if we take into account all individual subjects measured, we find that the number of medium-

headed is very small. Out of 3,090 American-born Hebrew boys and girls there are only 13 long-headed individuals (10 boys and 3 girls); out of 2,942 foreign-born Hebrew boys and girls there are 4 long-headed individuals (boys only). On the basis of Boas' tables presented in his appendix (Tables III, 5, *a*, *b*; Table IV, 4, *a*, *b*) we find that the bulk of both American-born and foreign-born Hebrew boys and girls belong to the same brachycephalic (or rather to the sub-brachycephalic) type at all ages represented. The only exception is the age of 17 in the case of American-born Hebrew girls, whose largest percentage belongs to mesocephaly (50 per cent.). The rest are distributed as follows: 36.4 per cent. brachycephaly, and 13.6 per cent. dolichocephaly.

If we compare the percentages of the whole, regardless of age, we have the following table:

TABLE II

| | Dolichocephaly | Mesocephaly | Brachycephaly |
|---|----------------|-------------|---------------|
| I. Foreign-born Hebrew boys. | 4 | 12 | 84 |
| II. Foreign-born Hebrew girls. | 2 | 12 | 86 |
| III. American-born Hebrew boys. | 3 | 27 | 70 |
| IV. American-born Hebrew girls. | 5 | 26 | 69 |

So far as these results go it can not be said that there is a real sex difference (a fact found also by Wissler (68) in his measurements of college students, Columbia University), and, therefore, we may combine these percentages under the two headings thus:

| | FOREIGN-BORN HEBREWS | AMERICAN-BORN HEBREWS |
|-----------------|----------------------|-----------------------|
| Dolichocephaly: | 3 | 4 |
| Mesocephaly: | 12 | 26 |
| Brachycephaly: | 85 | 70 |

The ratio of these types does not show any "far-reaching change," because it deals *with two distinct groups*, and does not affect the type—the bulk in both belonging to brachycephaly. The tables show that there is a difference of 1 per cent. in dolichocephaly, 14 per cent. in mesocephaly, and 15 per cent. in brachycephaly, but *it is not known what the differences were in the parents of these two groups.*

Again, Boas' theory is based not on percentile values but on averages, showing that there is not one single age represented either by long-headedness or medium-headedness. Boas' figure 1, representing the comparison of head forms of American-born and foreign-born Hebrews, has no bearing on his conclusion, that "the east European Hebrew, who has a very round head, becomes more long-headed" on American soil. The differences found by Boas, if they have any real meaning, may be regarded as the normal differences of separate groups, such as are frequently noticed in separate parts of the same people.

What is true of American-born and foreign-born Hebrew males and females is also true of the Sicilians born here and abroad. Table I does not prove Boas' conclusion that the south Italian, who in Italy has an "exceedingly long head," becomes more short-headed, because at all ages represented in this table there is not a single year represented either by "exceedingly" long-headed or by the lowest degree of dolichocephaly. The only conclusion we can draw from Boas' results of the cephalic indices of the American Sicilians is that the foreign-born American Sicilians, males and females, from 5 to 18 and over, are highly mesocephalic (cephalic index, 78-79), with the exception of the ages 5 (males, 80.8), 6 and 7 (females, 80.2; 80), the cephalic indices of which are very slightly broad-headed.

In regard to the American-born Sicilians, both males and females, we might conclude that the cephalic index is slightly above 82 only at the age of 12 (ceph. index, 82.1), in males, and at 6 and 16 years of age in females, whose cephalic indices are 81.2 and 85.0 respectively. The only striking difference affecting the type is shown at the age of 16 where the foreign-born Sicilian females are highly mesocephalic (78.4) and their American sisters of the same age are brachycephalic (85.0). This difference may, however, in the small number of cases, be entirely incidental. Boas also says that the adult American-born Italians are "few in numbers," but he does not state the exact number. Even in his appendix there is not a single table referring to Sicilians; and it is, therefore, impossi-

ble to see what the number of cases involved in every year tested, and what the individual distribution of cephalic indices is.

If we take Boas' results as they are, and compare them with those of other school anthropologists we shall see that both American-born and foreign-born Hebrews, males and females, are more or less sub-brachycephalic throughout the ages measured. These individuals agree with the subjects measured by Hoesch-Ernst, Hrdlička, Landsberger, O. Ranke, Reuter, and Teumin. In addition to that we may mention that the average figures of Matiegka Vosilyev, Schliz, Kraitschek, Engelsperger and Ziegler, and many others, agree with Boas' results in regard to the cephalic type of his Hebrew individuals. Schwerz (68a) measured recently 1,788 individuals in Kanton Schaffhausen, Switzerland, and found that all of them were more or less brachycephalic: 83.1 (at the age 6-7 years), 83.5 (7-8), 83.7 (8-9), 82.4 (9-10), 83.9 (10-11), 83.1 (11-12), 83.2 (12-13), 82.9 (13-14), 83.4 (14-16), 82.8 (16-17), 82.5 (17-18), 82.8 (18-19), 82.9 (19-20), 82.5 (over 20 years).

In regard to the American-born and foreign-born Sicilians Boas' average figures show that they are of mesocephalic type. Compared with the results of other authors mentioned in Table I we see that Boas' Sicilians agree with the type of the head form of West's subjects in America, and with that of pupils in Aberdeen, Edinburgh, Liverpool, and Birmingham (England). In addition we may mention that the high mesocephalic type was also found by Browne, Beddoe, Gray and Tocher (in England), and by Wissler and MacDonald (69) (in America).

Referring to his first conclusion Boas says:

"This fact is one of the most suggestive ones discovered in our investigation, because it shows that not even those characteristics of a race which have proved to be most permanent in their old home remain the same under our new surroundings; and we are *compelled* to conclude that when these features of the body change, the whole bodily and mental make-up of the immigrants may change" (p. 8).

A short time ago a well-known New York magazine made a sarcastic reference to the old statement "You can not change human nature," based on Boas' conclusions.

b. Boas' Second Conclusion

"The influence of American environment upon the descendants of immigrants increases with the time that the immigrants have lived in this country before the birth of their children."

But this conclusion does not affect the type of the head form, at least. Here is Boas' table (p. 10):

TABLE III

| | Cases | Cephalic Index | Average Age |
|---|-------|----------------|-------------|
| <i>Sicilian:</i> | | | |
| Foreign-born boys 5 to 12 years old | 241 | 79.5 | 9.6 |
| American-born boys 5 to 19 years old: | | | |
| Born less than 10 years after arrival of mother | 375 | 80.9 | 10.0 |
| Born 10 years and more after arrival of mother | 127 | 81.8 | 9.5 |
| <i>Hebrew:</i> | | | |
| American-born boys 7 to 10 years old: | | | |
| Born 10 years and more after arrival of mother | 290 | 82.3 | 9.2 |
| Born less than 10 years after arrival of mother | 257 | 82.4 | 9.2 |
| Foreign-born boys 7 to 10 years old | 179 | 84.6 | 9.1 |

This table shows clearly: (1) that all Hebrew boys (both those born less than 10 or those born more than 10 years after arrival of mother in America and those born in Europe) are of the same sub-brachycephalic type (not one of them is represented by the average hyper-brachycephaly!); (2) that all Sicilian boys are of the mesocephalic type of rather high degree. The American-born and foreign-born Hebrew and Sicilian boys differ only in degree, which may be considered as something normal on account of the possible errors in measuring and calculations, and to the comparatively small number of cases, or, especially, as due to corresponding differences in the parents.

In this table Boas compares 5-12 years old foreign-born and 5-19 years old American-born Sicilian boys with the 7-10 years old Hebrew boys born in America and Europe. The range of age (and, of course, greater individual variation) in Sicilian boys is 14 years and in Hebrew boys—only 3 years. Again the average values for these American-born Sicilian and Hebrew boys does not correspond with Table IH (p. 12). According to this table the average value for the American-born Sicilian boys 5-19 years old is 80.5, not 81.3 as is suggested by Boas' Table II (the average of 80.9 and 81.8). According to our calculation from Table III the average value for the American Hebrew boys 7-10 years old

is 82.7, not 82.3 as suggested by Boas' Table IV (the average of 82.3 and 82.4). According to our calculation from Table III the average value for the American-born Hebrew boys 7-10 years old is not 84.6 but 84.4. It is very interesting to note that Boas gives no tables presenting the individual distribution of cephalic indices of Sicilian and Hebrew boys born less than ten years, or ten years and more, after arrival of mother. All that he gives is the year of arrival of foreign-born Hebrew boys and girls, and the year of arrival of mothers of American-born Hebrew boys and girls (pp. 40-42) without any data in regard to their cephalic indices.

c. Boas' Third Conclusion

"The changes in head form which the European races undergo here consist in the increase of some measurements, in the decrease of others."

So, for example, Boas found that the length of the head is increased in American-born Hebrews and decreased in American-born Sicilians; the breadth of head is decreased in American-born Hebrews, but increased in American-born Sicilians.

But what is the nature of this decrease or increase? Table IV (see next page) will tell the whole story.

From this table we may figure out the increases and decreases, if foreign-born subjects are compared with those born in America. The average of maximum increase of the length in the Hebrews is 3.8 mm. at the age of 19 years; the average minimum increase for the same race is 0.8 mm. And here is an exception. At the age of 6 the foreign-born Hebrew boys excel their American-born brothers in the length of head by 0.6 mm. In regard to the Sicilian boys we see that the average maximum decrease of length of head is 7.6 mm. at the age of 18 years; the average minimum decrease is 2.1 mm. at the age of 5 years. At the age of 10 years both are on the same average level, and at the ages of 14 and 17 years the American-born Sicilian boys excel their foreign-born brothers by 0.5 mm. and 7.0 mm. respectively. And there are other irregularities:

The average maximum decrease in the breadth of head of the American-born Hebrew boys is 5.7 mm. (at the age of 18 years) and their average minimum decrease is 1.0 mm. (at the age of 13 years), with one exception at the age of 19 where there is an increase

TABLE IV

| Age | Head Form of Foreign-born and American-born Hebrews | | | | | | Head Form of Foreign-born and American-born Sicilians | | | | | |
|-------------------|---|---------------|---------------------|---------------|----------------|---------------|---|---------------|---------------------|---------------|----------------|---------------|
| | Length of Head (mm.) | | Width of Head (mm.) | | Cephalic Index | | Length of Head (mm.) | | Width of Head (mm.) | | Cephalic Index | |
| | Foreign Born | American Born | Foreign Born | American Born | Foreign Born | American Born | Foreign Born | American Born | Foreign Born | American Born | Foreign Born | American Born |
| 4 years..... | — | — | — | — | — | — | — | 171.8 | — | 137.7 | — | 80.2 |
| 5 "..... | 169.9 | 171.9 | 144.3 | 142.7 | 85.0 | 83.0 | 176.5 | 174.4 | 142.5 | 139.7 | 80.8 | 80.1 |
| 6 "..... | 171.8 | 171.2 | 144.3 | 144.0 | 84.1 | 84.1 | 177.7 | 173.5 | 140.5 | 141.1 | 79.2 | 81.2 |
| 7 "..... | 173.3 | 174.4 | 145.3 | 144.9 | 84.0 | 83.1 | 179.3 | 176.8 | 142.4 | 142.9 | 79.5 | 80.5 |
| 8 "..... | 174.9 | 175.7 | 147.2 | 145.7 | 84.3 | 83.0 | 179.5 | 177.0 | 141.7 | 143.1 | 78.9 | 80.8 |
| 9 "..... | 175.5 | 177.8 | 148.8 | 146.3 | 84.9 | 82.3 | 181.7 | 179.2 | 143.3 | 144.5 | 78.9 | 80.6 |
| 10 "..... | 176.3 | 178.2 | 149.1 | 146.9 | 84.6 | 82.5 | 180.3 | 180.3 | 144.3 | 146.4 | 79.6 | 81.0 |
| 11 "..... | 178.0 | 179.7 | 150.3 | 147.9 | 84.5 | 82.3 | 182.0 | 179.1 | 145.0 | 146.5 | 79.9 | 81.8 |
| 12 "..... | 178.1 | 180.6 | 150.6 | 148.6 | 84.6 | 82.3 | 183.7 | 179.6 | 144.9 | 147.2 | 79.9 | 82.1 |
| 13 "..... | 179.3 | 182.0 | 150.6 | 149.6 | 84.0 | 82.3 | 184.0 | 179.8 | 146.2 | 146.7 | 79.5 | 81.9 |
| 14 "..... | 180.9 | 183.5 | 151.9 | 150.3 | 84.1 | 82.0 | 183.9 | 184.4 | 146.2 | 147.2 | 79.0 | 80.3 |
| 15 "..... | 182.9 | 185.1 | 153.7 | 151.3 | 84.1 | 81.7 | 186.7 | 183.5 | 147.2 | 149.0 | 78.8 | 81.2 |
| 16 "..... | 183.1 | 186.0 | 153.2 | 151.6 | 83.7 | 81.5 | 189.8 | 183.6 | 146.2 | 147.0 | 77.1 | 80.1 |
| 17 "..... | 183.6 | 186.9 | 153.5 | 150.9 | 83.0 | 80.9 | 191.3 | 198.0 | 145.9 | 150.5 | 76.4 | 76.0 |
| 18 "..... | 186.6 | 187.4 | 154.5 | 148.8 | 83.0 | 79.6 | 192.4 | 194.8 | 148.4 | 155.8 | 76.0 | 80.0 |
| 19 "..... | 185.1 | 188.8 | 153.5 | 154.7 | 82.9 | 82.0 | 189.9 | — | 148.1 | — | 78.0 | — |
| 20 and over. | 187 | 188.8 | 155.4 | 153.7 | 83.0 | 81.4 | — | — | — | — | — | — |

of 1.2 mm. The average maximum increase of the width of head of American-born Sicilian boys is 7.4 mm. at the age of 18; the average minimum increase is 0.5 mm. (at the ages of 7 and 13); the exception to this rule is the age of 5 showing a decrease of 2.8 mm.

The fact is that there are exceptions in Boas' "fundamental" and "far-reaching" discovery. And we may ask, are these increases and decreases of two or three millimeters on the average due to "the American soil" and "financial panics" rather than to errors in measuring, calculating, and comparing results and differences in the parental stock?

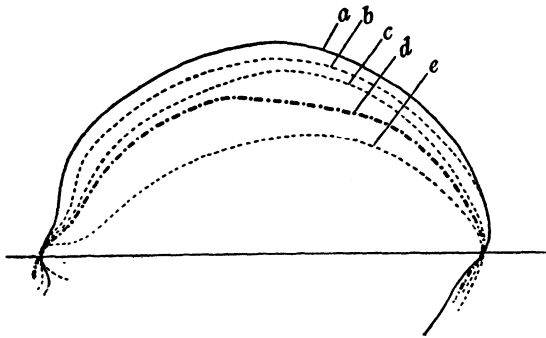


FIG. 55.—a, average European skull; b, Spy skull; c, Neanderthal skull; d, skull of *pithecanthropus*; e, skull of gorilla.

It is interesting to note here that all previous anthropologists found almost the same length of skull in the Europeans, Spy man, Neanderthal man, *pithecanthropus*, and gorilla. The difference of their skulls is shown in the height of the crania, as it is indicated in the accompanying figure (fig. 55) (after Wheeler: *Anthropology*, New York, 1909, p. 36; or Keane: *Ethnology*, Cambridge, University Press, 1901, p. 145).

There is no difference in the length and breadth of the head, but only in the height. Boas did not measure the height of the head. This third head dimension is of about the same difficulty in measuring as the other two head dimensions, the only difference being, perhaps, that the measurement of the height of the head

needs more time and trials until the required safety is reached. All modern anthropometricians measure the height of the head (Hoesch-Ernst, Engelsperger and Ziegler, Browne, Teumin, Reuter, Hrdlička, Martin, etc.). By means of this third head dimension could be figured out other, perhaps more important, cephalic indices and formulæ (*i. e.*, length-height cephalic index, breadth-height cephalic index, cephalic module, and cephalic capacity according to the formulæ of Venn-Galton, Schmidt, Pearson and Lee, or Hoesch-Ernst).

d. Boas' Fourth Conclusion

"The differences in type between the American-born descendants of the immigrant and the European-born immigrant develop in early childhood and persist throughout life. . . . The influence of American environment makes itself felt with increasing intensity, according to the time elapsed between the arrival of the mother and the birth of the child."

But a careful study of Boas' Table IV compels us to disagree with his conclusion that it "clearly shows the *strong* and *increasing* effect." This conclusion is of still less value if we apply it to the cephalic index. Let us study carefully his corresponding table giving the cephalic index of Hebrew males (p. 19) (see Table V opposite).

Are these differences in cephalic index of the total series and of foreign-born and American-born Hebrew males "the difference in type," and due to the "influence of American environment?" In other words is a *plus* or *minus* of 0.1 mm. and a *difference in type* due to the *American* soil? Besides this deviation from the average does not affect the type of the head form. Both foreign-born and American-born Hebrew males (regardless of the time of arrival of their mothers) fall within the brachycephalic type. In this connection I desire to call attention to what appears to me too great discrepancies in the numbers of cases recorded under different heads.

We find in the figures of the above table that one age is represented by 2 and the other by 223 cases (ages of 19 and 14 respectively). In the column three we see that the age of 6 is represented by 28 cases, but the corresponding tables of the length and breadth of head (pp. 17 and 18) have only 25 cases. The age

TABLE V

| Age | Total Cephalic Index | | Differences in Cephalic Index of Total Series and — | | | | | |
|-------------------|----------------------|-------|---|-------|---|-------|---------------------------------------|-------|
| | | | Foreign-born | | American-born | | | |
| | mm. | cases | mm. | cases | Born less than 10 Years after Arrival of Mother | | Born 10 Years after Arrival of Mother | |
| | | | | | mm. | cases | mm. | cases |
| 5 years | 83.5 | 71 | +15 | 18 | ±0.0 | 29 | —101 | 24 |
| 6 " | 84.1 | 57 | ± 0.0 | 16 | +0.4 | 28 | —0.8 | 15 |
| 7 " | 83.3 | 75 | + 0.7 | 18 | +0.2 | 32 | —0.7 | 25 |
| 8 " | 83.3 | 98 | + 1.0 | 27 | +0.2 | 45 | —1.6 | 26 |
| 9 " | 83.0 | 185 | + 1.7 | 51 | —0.5 | 34 | —1.0 | 100 |
| 10 " | 83.0 | 359 | + 1.6 | 83 | —0.4 | 137 | —0.6 | 139 |
| 11 " | 82.9 | 442 | + 1.6 | 114 | —0.2 | 189 | —1.1 | 139 |
| 12 " | 82.9 | 521 | + 1.7 | 133 | —0.2 | 225 | —1.2 | 163 |
| 13 " | 82.8 | 498 | + 1.2 | 137 | —0.2 | 208 | —0.9 | 153 |
| 14 " | 82.5 | 477 | + 1.6 | 120 | —0.2 | 223 | —1.0 | 134 |
| 15 " | 82.4 | 331 | + 1.7 | 94 | —0.4 | 174 | —1.6 | 63 |
| 16 " | 82.6 | 73 | + 1.1 | 36 | —0.8 | 23 | —1.6 | 14 |
| 17 " | 82.2 | 40 | + 0.8 | 24 | —1.4 | 10 | —1.2 | 6 |
| 18 " | 82.4 | 27 | + 0.6 | 22 | —0.7 | 3 | —5.4 | 2 |
| 19 " | 82.8 | 37 | + 0.1 | 31 | +1.0 | 4 | —4.3 | 2 |
| 20 and over . . . | 82.9 | 803 | + 0.1 | 764 | — | — | — | — |

of 9 in the same column has 34 cases, but the corresponding tables show 61 cases each. The age of 10 in the same column has 137 cases, but the corresponding tables show 140 and 141 cases respectively. The age of 11 in the same column shows 189 cases but the corresponding tables show only 184 cases each. The age of 14 in the same column shows 223 cases but in the corresponding tables there are only 215 and 184 cases respectively. The age of 15 in the same column has 174 cases, and the corresponding tables only 154 and 126 respectively.

Again the age of 6 in the fourth column shows 15 cases and the corresponding tables 16 each; the age of 9 shows 100 cases, but the corresponding tables only 82; the age of 10 has 139 cases and the corresponding tables have 136 and 137 respectively; the age of 11 shows 139 cases, and the corresponding tables 144 each; the age of 14 has 134 cases and the corresponding tables 142 each; finally the age of 15 in the same column shows 63 cases and the corresponding tables 83 cases each.

The same table shows 803 cases at the age of "20 years and over" (first column), but the corresponding tables show 802 cases each; the second column of the same table shows 764 cases for the age of "20 and over," and the corresponding tables have 736 cases each.

It may be contended that all these errors do not materially affect the conclusions. We do not know. But we believe that these

and other methodological errors may be just the cause of the differences, and not the American soil and financial panics. Even by those minute deviations from the average it can not be certainly inferred that the greater variation of the figures means that the Hebrew or Sicilian is undergoing a modification of the shape of the head on American soil.

e. Boas' Fifth Conclusion

"The type of the immigrant changes from year to year, owing to a selection which is dependent upon the economic conditions of our country. This is shown by the fact that after the panic of 1893 a SUDDEN decrease in the general development of immigrants may be observed, which persisted for several years. A similar change seems to have taken place after the panic of 1907."

Here is Boas' table, referring to foreign-born Hebrews, men and women (p. 28):

TABLE VI

| Period of Arrival | Stature | Length of Head | Width of Head | Cephalic Index | Width of Face |
|-------------------|---------|----------------|---------------|----------------|---------------|
| | cm. | mm. | mm. | | mm. |
| 1880 | -0.5 | +1.7 | +1.5 | +0.1 | +3.5 |
| 1880-1884 | -0.8 | +0.2 | +0.7 | +0.0 | +1.6 |
| 1885-1889 | +0.5 | +1.2 | +0.3 | -0.4 | +0.4 |
| 1890-1894 | +0.1 | +1.6 | +0.4 | -0.5 | +0.2 |
| 1895-1899 | -0.9 | -1.2 | -0.3 | +0.3 | -0.4 |
| 1900-1904 | +0.7 | -0.9 | -0.4 | +0.2 | -0.7 |
| 1905-1909 | ±0.0 | -0.3 | +0.1 | +0.1 | -1.2 |

This table does not warrant such a broad conclusion it seems to me, and especially in regard to the head form as indicated by the cephalic index, because it is of the same sub-brachycephalic type, before and after the panic of 1893. The slight increase (0.3) of the cephalic index after 1893 is so small that we may with confidence say that it is due to something else than the financial panic. Even the absolute measurements of the length and breadth of head show such small differences that they can hardly be ascribed to it.

These differences are of no typical character or fundamental significance. The same may be said of Boas' differences in cephalic index between American-born and foreign-born Hebrew children and their own parents (see his Tables XVI and XVII). It is a fact

that all Jews, from Roumania, Galicia, Little and White Russia, Poland, Lithuania (according to Boas' Table XII), including the foreign-born and American-born Hebrew boys and girls, and, their parents, are more or less sub-brachycephalic. Even the differences which Boas found between parents and their children are normal differences in degree, which may be the result of the countless errors in such delicate measurements, and other causes.

IV. CRITICAL REMARKS ON DR BOAS' METHODOLOGY.

Regarding the methodology the following criticisms are to be made:

1. The prime condition in reporting cephalometric results is to give the *modus operandi*, to state exactly what is meant by antero-posterior and transversal head diameter. All that the author says about those two diameters is that the transversal diameter is the "width of the head," and that the second diameter ("or the length of the head") is measured from the forehead to the back of the head. But the "forehead" has at least three anthropometrical points—glabella, ophryon, and metopion. Perhaps the point most generally adopted was used, namely the point on the glabella, the space between the eye-brows, but it is not stated. Many anthropometricians (for example, Bertillon (70)) use the point situated on the root of the nose. And then, is "the back of the head" the inion, or the highest point on the occiput? Boas fails to state. Is the width of the head the maximum width of head taken above the ears wherever found? He also fails to inform us whether he followed the *Frankfurter Verständigung* (71), or the *International Commission Anthropométrique* (72) or some of the English systems (Cambridge or Dublin Anthropometrical Systems), for example the method given in the "Report of the Anthropometric Committee of the British Association" (London, 1910).

2. *Boas did not make all these measurements himself.* What assurance have we that his staff of thirteen anthropometrical amateurs exactly understood and applied with uniformity what was meant by the length and width of head? On page 36 of his report Boas gives a table of the measurements of his observers, and concludes

that the measurements are "quite comparable." We should like to enquire, however, whether those figures are averages of their "training" taken on the first and fourth Saturdays in May, 1909, the averages of the second Saturday of their practice, or the values of the first or last of their trials. This very important feature is not explained, and it is difficult to understand what the purpose was in giving the table. But, suppose these figures are the values of the final trial; then it is difficult to imagine what the rule is in such delicate practice for original research work. Bertillon, Martin, and other anthropometricians require from their students an exactness for the length and breadth of the head within the limit of about 1 mm. If the difference is as much as 2 it is regarded as a discrepancy beyond which measurements cease to make identification of the subject measured possible; and, if it is over 2, mistakes of a serious character are made beyond which non-identity can be made. The personal equation of Boas' thirteen observers who made successive measurements by way of preliminary practice on each other is in every observer above 0.5 mm. Now, if these figures represent the final test trial of those observers, then we can not understand how they can be qualified to take up such a delicate piece of research work. It is not stated how many times a subject was measured. Perhaps each subject was measured ten times. There would be probably ten signalments, differing by very small quantities. These differences can be, of course, ignored until they reach a certain point after which they destroy the value of the measurements. Have Boas' observers reached this point? Again, if this point is reached during the practice when each observer's measurements are controlled by their master, what personal equation can we expect from their main measurements of school children and adults! Boas, indeed, says that in the case of school children a "considerable number of control measurements were made," but he gives no details.

We have to keep in mind the fact that the method in the collecting of his data is not *individualistic* but *collective* ("generalized," *en masse*) in nature. This means Boas did not study the effect of "American soil" and "financial panics" on the *same* individuals during a period

of time representing the age of his subjects (4-20 years "and over") but he collected this data in a very short period, measuring a large number of immigrants. Why is it not possible that all the supposed "facts" thus brought to light may be quite spurious, owing to the great individual differences which may and do exist in the subject? Just on account of these individual differences it may be that the variations within a group of a given age are such as to completely obliterate all the actual peculiarities of the curve of growth. This difficulty is not touched upon in his theory.

4. Another difficulty with this theory is that *big conclusions are drawn from comparatively few measurements*. We are told that the measurements include about 30,000 individuals, but in the report are given only the results of measurements on (1) 6,032 foreign-born and American-born Hebrew boys and girls (Tables III and IV, in Appendix of Boas' report), 730 foreign-born adult Hebrew males, according to place of birth (Table I, Appendix), together 6,752 Hebrews; (2) 743 Sicilian boys (both born in Italy and America) but the number of American-born and foreign-born girls is not given. In regard to the adult American-born Italians, Boas says that they are "few in numbers." We are surprised indeed that he has not a single table in his appendix referring to Sicilians, yet throughout his report he comes again and again to his discovery that very short-headed Jews are becoming "long-headed" and very "long-headed" Sicilians "short-headed." Instead of these tables, he gives tables occupying 11 full pages, relating to his old study of the stature of Toronto children, and having no connection at all with his study of the descendants of immigrants. Again, from those tables given in the Appendix it is very hard to fix the exact number of Hebrews. According to Table I, Appendix, giving the types of foreign-born adult Hebrew males in regard to the place of birth, Table III, giving the cephalic indices of foreign-born boys, and Table IV, showing the cephalic index of foreign-born girls, the whole number of Hebrew immigrants is 3,672. But from Table II (also in Appendix, pp. 60, 64) we see that there are 1,527 "types of foreign-born Hebrews immigrating at different periods." Where are the rest of the 2,145 foreign-born Hebrews?

The distribution of individuals according to place of birth, different periods of immigration, and ages does not seem to be an ideal one.

As, for example, Hebrews from Lithuania represented by 82 cases and those from White Russia by 163. Or, the Hebrews immigrating during the period between 1900 and 1904 are represented by 214, and before 1880 by only 22 cases. Or, the cephalic index for foreign-born at the age of "20 and over" is based on 764 cases, and at the age of 6 there are only 6 cases. The American-born Hebrew boys at the age of 12 are represented by 388 cases, at the age of 18 by 5, and at the ages of 4 and 19 by 6 cases only.

In regard to the cephalic index of the foreign-born Hebrew girls the age of "18 and over" is represented by 895 cases, and the age of 4 by one single girl only. Of American-born girls, the age of "18 and over" is represented by 65 and the age of 4 by 6 cases.

Now, with such a very uneven distribution of cases it is impossible to accept the given explanation of his results. The even distribution of pupils is not an unimportant scientific requirement. The modern anthropological investigations of the pupils of Meumann and Martin (Engelsperger and Ziegler, Hoesch-Ernst), Reuter, Edinburgh and Aberdeen school anthropometric investigations, etc., had the same number of each year and sex. Even Quetelet (73) used this principle in his measurements in his day.

In looking over the tables dealing with the Hebrew subjects we have found a few more errors, which ought not to be found in the work of an expert biometrician of high rank, whose investigations are carried out by a "small army of serious, scholarly-looking young men" and generously supported by the Immigration Commission.

So, for example, the first table on page 60 of Boas' report shows that there are 214 cases of cephalic indices at the period of 1900-1904 and the two corresponding tables of the length and breadth of head show only 213 cases each. The first table on page 64 shows 162 cases of cephalic index in the period of 1890-1894, but corresponding tables show 161 and 163 cases respectively. On page 68 the average of the length of head of 18 foreign-born Hebrew boys is given as 169.9 instead of 169.4.

The first table on page 72 shows 764 cases of cephalic index at the age of "20 and over," but the corresponding tables show only 763 cases. On page 82 there are 24 cases of cephalic index at the age of 14, but the corresponding tables show 24 and 23 cases respectively. On the same page (second table) there are 65 cases at the age of "18 and over," and the corresponding tables show 66 and 67

cases respectively. On page 90 there are 100 cases at the age of 9, but the corresponding tables show only 82 cases. On the same page there are 139 cases at the age of 10, but the corresponding tables show 137 and 136 cases respectively. The age of 11 is represented by 139 cases, but the corresponding tables show 144 cases each. The age of 14 is represented by 134 cases, and the corresponding tables show 142 cases each. The age of 15 years shows 63 cases, but the corresponding tables show 20 cases more. The ages of 18 and 19 are represented by 2 cases each, but the corresponding tables of the length and width of head show not one single case.

5. Another difficulty in the way of accepting Boas' theory is the fact that *his statements in regard to the methods of his other records and measurements are not as complete as they should be*. So, for example, he does not say what he means by the figures representing the age of his subjects. Do they represent the "last birthday" or the "nearest birthday" or, perhaps, something else? The same ambiguity we find when we want to know what is meant, by the "general physiological development of the individual," "stature," "weight," "width of face." All that he says about "general physical development" is that observations were made on pubescence as a means of determining the approximate physiological development." However, he mentions that the "method of these observations has been developed by Dr C. Ward Crampton, but it is available only for the short period of adolescence." The question is now, was the same, or similar, or a different method used from that of Crampton and what is this method? Again, he says that in "those New York schools in which bathrooms are established it was possible to obtain the weight of children without clothing." But how about other schools and individuals investigated? We also fail to see the precise method in measuring the stature of body. Did the subjects stand in the upright position *with* or *without* shoes?

Again, what is meant by the distance "between the zygomatic arches"? This measurement is subject to great errors if the method of taking is not exactly stated, especially in measuring the living. Is it not possible that the "surprising and unexpected changes" in width of the face and other measurements are due to inexact statements and consequent inaccurate measurements?

A similar difficulty confronts us in regard to the instruments used.

On page 33 of his report we are told that the "color of hair, eyes and skin" was studied. On page 37 we are told that "a standard of hair-colors made by Messrs. B. Dickson & Co., of New York" used. But this "standard" is not described. Is this standard something new in principle and structure, or is it superior for example to the "Haarfarbentafel" of Fischer? Is there any scientific reason for preferring to use "no samples of eye-colors" instead of Martin's eye-colors (which, according to Boas, were "not as successful as might have been desired"), or Bertillon's chart of the colors of the human iris? Preference seems to have been given to guess-measurements of the eyes by young men of little experience over the best scientific means in that matter, "on account of the great expense involved in the purchase of a sufficient number of sets" (the "Augenfarbentafel" of Prof. Martin costs about \$16). Nor were the "standards" for the determination of the skin-color used.

On page 34 of his report Boas says that he copied the full records which have been kept in the Newark Academy for many years. He gives a blank used for recording the measurements in this school but he does not state *how many* pupils were measured, *who* measured them, *what* was the method in measuring the "stature," "weight," "grip," "color of eyes," "hair," "skin," "length of head," "width of head," and "width of face." Again Boas says that he used this record for the sake of studying the "American families settled in this country for several generations and living under more favorable conditions." Do results of his report include the results of these records? If these records refer to the American-born Hebrew and Sicilian boys, from what tables can we see this fact? Did he treat the results of his staff together with these strange records?

On page 34 of his report Boas says that "in the schools it was necessary to obtain statistical information from the parents." He gives a blank for collecting this information but he does not state who filled out those blanks—the members of his staff, teachers, parents, or children. As the blank includes the following headings:

"I . . . came to America . . . years ago; in the year . . . My father came to America . . . My mother came to America . . . Father's father . . . Father's mother . . . Mother's father . . . Mother's mother came to America . . .," there is room for the suspicion that these blanks were filled in by children.

6. Another difficulty in Boas' theory of the head form is that *he explains it by the use of means to which, I claim, he is not entitled.* On page 11 of his report he gives three sketches of head form which are reproduced in the accompanying figure (fig. 56).

In the upper row there is "the more rounded" head form of the foreign-born Hebrew (1), and "the more elongated" head form of the Sicilian (2). Below these two there is a form of the head of the descendants of the Hebrews and Sicilians born more than 10 years after the arrival of their mothers (3). Careful study of these three

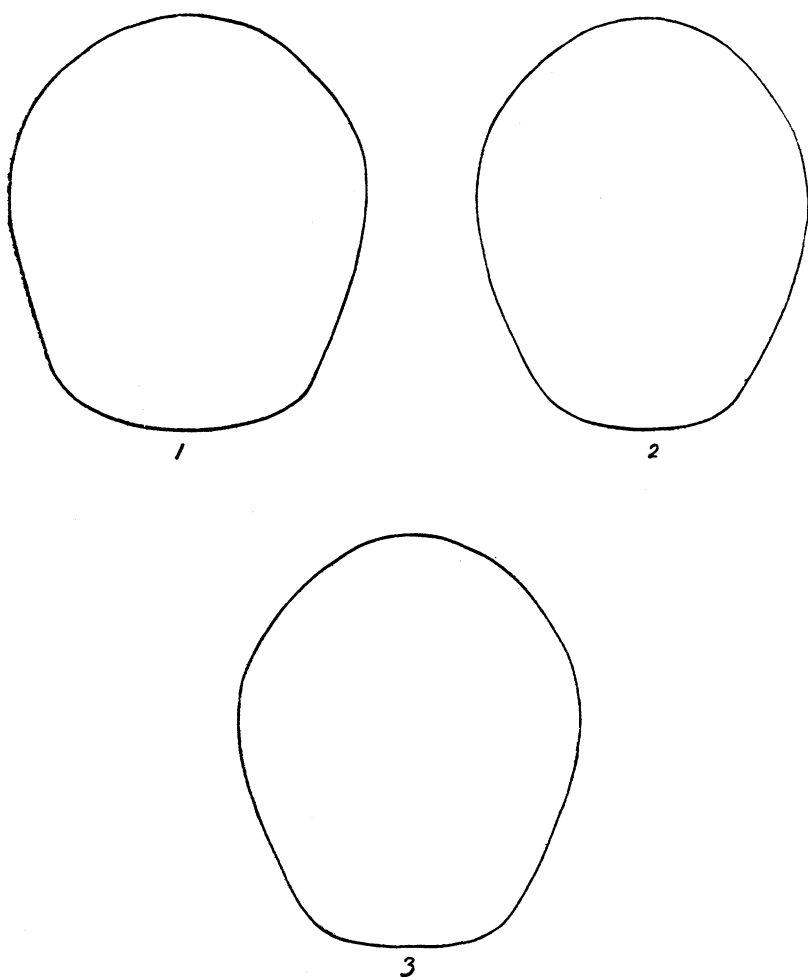


FIG. 56.—Slightly reduced from Immigration Commission Rep., Senate Doc. No. 208.

sketches will show that their cephalic indices are of the same type; all three represent brachycephaly, since the length of each of the three (original) sketches is almost the same (56 mm.), and the width 49, 46, and 46 mm. respectively. The corresponding indices of these sketches is above 82, representing the same type of head form. The slight difference is one of degree only; and, if we take into account the possible errors in such delicate head measurements, and especially if we have in mind the difficulties above mentioned, we may be

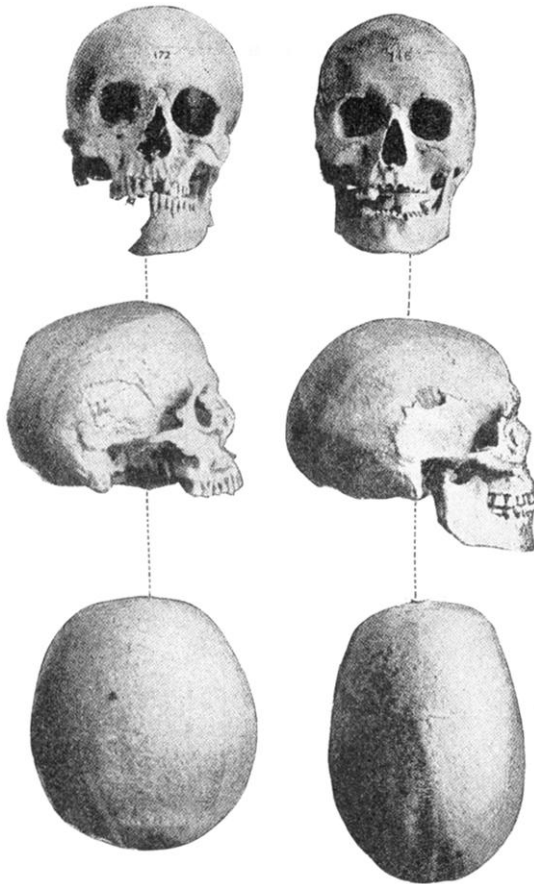


FIG. 57.—Upper, front, and side views of skulls of the Long and Round Barrow Races, photographed by A. C. Haddon from specimens in the Cambridge Anatomical Museum. On right, Long Barrow, Dinnington, Rotherham. Length, 204; breadth, 143; cran. index, 70.1; male. On left, skull of a man of the Round Barrow Race, from a secondary interment, two feet below the surface, in a *long barrow*, Winterbourne Stoke. Length, 177; breadth, 156; cran. index, 88.1. (Reproduced from Haddon's *The Study of Man* by courtesy of G. P. Putnam's Sons, New York.)

justified in doubting whether these differences are due to the effect of "financial panics" or "American soil."

But these sketches were made so that they give an impression of "more rounded" and "more elongated." This impression is not due to the mere ratio between length and width of head but

to the shape of head *as viewed from above*. And then, in his plan of investigation he did not use this, Sergi's "natural system" of classification of the shape of head. He did not even measure either the total horizontal circumference, or the forehead (the smallest width of forehead), or any other part of the head form, except the length and width of the head. These sketches of head forms are, therefore, based not on his measurements but on pure imagination. According to Sergi's natural classification, the head form may be "ellipsoides," "ovoides," "pentagonoides," "sphenoides," etc. (74) but not "more rounded" or "more elongated." To show the reader what a "more elongated" and "more rounded" skull really means, we will use the accompanying figure from Haddon (75) (fig. 57). In Boas' sketches there are no "more elongated" head forms but all of them are of the same brachycephalic type, more or less broad. There is no reference either to Sergi's demonstration that a head which, according to the measurements of the cephalic index ought to be of dolichocephalic type, might be of brachycephalic type and *vice versa*, or to Manouvrier's (76) theory that the variations of the cephalic indices are the most insignificant physiologically.

7. Attention must also be called to Professor Boas' *citation of authors*. He has apparently overlooked almost all the new anthropometrical movements outside of America, and it would seem from his references that his reading here has been uniquely restricted. He mentions the names of few authors (Gould, Baxter, H. P. Bowditch, C. W. Crampton, M. Fishberg), and gives only one reference (p. 38). This quotation is of such a nature that we can not see any special scientific reason for quoting one authority and not the works of other authors mentioned also.

Further, on page 46 Professor Boas says:

"In all races of man the head becomes slightly longer with increasing age, so that a young son is always more round-headed than his father." He does not state who discovered that fact nor does he give any references. He states this result in a categorical manner. But the fact is that authorities do not agree on this point and dogmatic assertion is misleading. So, for example, Weissenberg (77), who

studied Russian Jewish children *en masse*, found the following indices: 86.4 (for 3 newborn children), 84.7 (for 4 five year old children), 84.0 (for 25 ten year old), and 82.5 (for 100 "grown" children). But such regular decreases were not proven by any other author. And then the number of Weissenberg's cases is too small to draw any general conclusions from, especially if we take into account that he did not measure the same children from year to year. Landsberger, who measured the same children yearly (from 1880-1886) found an average yearly *increase* of 1.0 in cephalic index. Lucae (78), who studied 20 boys from their third to their fourteenth year, found a slight decrease of cephalic indices in 16 boys; in one case the cephalic index was the same from six to ten years of age, and in three cases there was an increase from year to year. O. Ranke, who studied a large number of children, could not establish Weissenberg's results. Lecourtois (79) and Bonnifay (80) agree with Ranke. Lecourtois, on the basis of his own measurements, claims that the cephalic index of a newborn infant remains constant throughout life. Bonnifay found rather a slight increase of the cephalic index with age. Gray (63) in his Aberdeen report remarks that the cephalic index was less in the older than the younger girls, but in boys it was the same at all ages tested between six and fifteen years.

The comparison of the results of our Table I will show clearly that Weissenberg's regularity of decrease in the degrees of cephalic index (not in cephalic type!) is not proven. And even the supposed "general irregularity" of West and others is of doubtful scientific value, because these "general regular increases" may be due not to age or any "law" of the cephalic periodicity (similar to the periodicity in the body growth) but to countless mistakes and errors in measurements, comparisons, and mathematical calculations. Some biometricians and experimental psychologists make a fetish of figures. Mathematical calculations in anthropometry and experimental psychology, as also in experimental pedagogy, are of fictitious value if we do not know exactly the nature of their *modus operandi* and the exact value of their "units."

All that we can say from these "general regularities" is that the

type of the head form is not materially affected by age; it is always either brachycephalic or mesocephalic. That these differences may be due to methodological mistakes and personal equations was proven by Binet (31), who measured the same pupils with the same instruments on several days, and found differences in results. He also compared his results with those of three well-known French anthropometricians, Manouvrier, Deniker, and Lapique, who used the same instruments (compass-glissière à triple graduation), and measured the same pupils on the same day, and found that the results did not agree. Gray (63) found that the measurement with Hepburn's callipers was uniformly greater than the measurements with Hay's instrument. All these facts are only an additional reason why the cephalic measurements must be taken not once or twice in succession, but five, ten, or even more times, until the difference required of these measurements is limited to about 0.5 to 1 mm.

Yes, the two common head measurements (length and breadth) are not in themselves difficult, but they require a good deal of attention, patience, and perseverance. Anthropometrical and cephalometric work is like all other work: the more attention is paid to its details, the better results it yields.

V. GENERAL SUMMARY

To summarize then, the main objections to the new theory of Boas are:

1. *That his theory of the head form does not agree with his actual results.* From his tables we see that all Hebrews (born in America and in different countries of Europe) are of the same sub-brachycephalic type. Not one age, not one sex, not one individual of Hebrew nativity is represented either by dolichocephalic or by mesocephalic type. The same is true in its way of the Sicilians measured. They are of a high mesocephalic type, both in America and in Europe.

2. *That the normal differences in degree of these two types are probably not due to the "American soil" or "financial panics," as Boas maintains, but to the countless methodological, technical, and mathematical difficulties which we have shown.* It is a well known fact that even

specialists, experienced in technical methods of measurement, can make serious mistakes in measuring the same head, if they have not taken the precaution to harmonize their methods at the beginning, while Boas' results are based not on his own measurements but on those of thirteen amateurs. It is also interesting in this connection to note Boas' own statement, that the work of his staff "had to be pushed with considerable energy," "owing to the necessity of collecting material *in time* for the present report."

3. *That his method in collecting scientific data is uncritical; he fails to state exactly the points from which measurements were made, to explain his modus operandi, or to give an objective account of the previous theories of the head form, while there are many errors and inconsequences in his tables.*

4. *That his theory is based rather on a cross-section of the facts than on a genetic interpretation of them. It is only a genetic description and explanation of them that can give a trustworthy basis for a theory.* "Durch das Werden wird das Gewordene klar." What we also need in physical anthropology is to learn the methods and grammar of physical anthropology in relation to historical, evolutionary facts. Boas ignores all previous theories of head form, even the American biological (G. Stanley Hall) and sociological (Ripley) interpretation of this large subject.

5. *That he began and finished the investigation in which he was put in general charge without requisite scientific exactness and care.* In the "Introductory" to his report we read the following:

"A small appropriation was made to test the question and see if the promise of results was sufficient to warrant the continuance of the investigation. *Almost immediately* it became evident that there might be much value in such a study, and the work has therefore been continued, although as yet only on a small scale."

It is to be regretted that he does not state on what grounds it became "almost immediately" evident.

The "mystery" of New York environment could be partially solved either by repeating the same measurements on the same subjects and correcting the tables or by attacking this big problem with less temper, but on a really new, scientific plan, which can stand any professional criticism. This was and is the only way to

save both the public and science from prejudicial, provincial, and narrow theories.

To conclude: *I contend that the theories advanced by Boas in regard to physical changes in the immigrants to the United States and their children neglect the various influences which, in different degrees, affect different subjects in the tests, and pours all data from whatever source into the statistical mill, which in consequence expresses an anthropologically meaningless result.*

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